A Hydrologic Study of the
Macatawa River Watershed

The Macatawa River at 84th Street in Zeeland Township, Ottawa County

State of Michigan
DEQ
Department of Environmental Quality

Hydrologic Studies Unit
Water Management Section
Land and Water Management Division
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Executive Summary

The Macatawa River watershed, which contains the cities of Holland and Zeeland, Michigan, has experienced the adverse effects of flooding on many occasions. The Michigan Department of Environmental Quality (MDEQ) conducted this study using the U.S. Army Corps of Engineers' Hydrologic Modeling System (HEC-HMS) to propose possible ways to reduce the impact of flooding in this area. A hydrologic model of the watershed is designed to predict flood flows for the Macatawa River using the current river configuration and land use. The model is then run with a proposed flood storage area in one of the upper subbasins of the river. The flood storage area has a definite impact on reducing the peak discharge, flood stage, and floodplain expanse during major flooding events. It is recommended that the degree of the impact be the subject of further study. Vegetated buffer areas along the watercourses of the basin are also identified. About 30% of the river's length has some degree of buffering. Further study is needed to determine the quality of the various buffer areas.

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I. Introduction

Over the years, major flooding in the Macatawa River basin has threatened the safety of residents, caused substantial property damage, and impacted the use of public facilities. Intense rainstorms have caused flash flooding in communities along the Macatawa River on numerous occasions. Major highways, including US-31 and M-31, have been closed due to flooding. Records from several past storm events describe the rescue of persons swept into the river by flood waters. In June of 1997, a U.S. Coast Guard helicopter rescued four people off the top of an overturned car stranded in deep water in Zeeland Township. Eight other people were rescued from other stranded vehicles. Road washouts and bridge damage were also reported in 1997 in addition to the disabling of two sewage lift stations which caused sewage backup at several locations. Articles from the *Holland Sentinel*, which describe additional examples of problems and damage experienced during flood events in the Macatawa River watershed, are located in Appendix C.

The damage due to flooding in developing river basins, such as the Macatawa, is becoming more evident because of increased human activity along the floodway. The proximity of structures and inhabitants to flood waters increases the potential for personal injury and property damage during floods. In addition, developed basins have more impermeable surfaces and other land uses that generate higher runoff volumes. As a result, rivers crest at increasingly higher levels and the impact of flooding becomes more severe.

The flood-related problems in the Macatawa basin highlight the need to study the behavior of this basin during major storm events. It is important to know how much runoff is contributed by the uplands and lowlands of the watershed to fully understand how flooding occurs throughout the basin. The timing of how runoff flows from one point to another in the watershed is also crucial. Computer models are the most effective means to study the potential impact of a storm before an actual storm occurs.

The hydrologic model is used to evaluate runoff throughout the watershed and estimate flow at locations along the Macatawa River and its tributaries during major storm events. The model is also used to analyze possible flood control measures to reduce the impact of flood waters on developed and agricultural land areas of the basin.

Figure 1. Michigan watersheds, showing the location of the Macatawa River watershed

II. Project Description

The goals of the study are as follows:

1) Construct a hydrologic model of the Macatawa watershed
2) Evaluate potential storage areas to be used for flood control
3) Identify potential buffer areas along the watercourses in the basin

The project serves two main purposes. First, the hydrologic model generates flood flow and stage data to predict flood volumes along the course of the Macatawa River and its tributaries. Second, these data are used to evaluate flood control measures.

III. **Description of the Watershed**

The Macatawa Watershed straddles the Ottawa/Allegan county line in western Michigan. The Macatawa River receives waters from numerous tributaries as it winds westward through the watershed. The watercourses traverse predominately agricultural land. However, the two cities of Holland and Zeeland and several villages, including Vriesland and Drenthe, are also along the route. The main branch of the river is 16.8 miles in length. The river empties into five-mile long Lake Macatawa, which outlets through a short channel that discharges into Lake Michigan. The total drainage area of the watershed is 174 square miles, which is small in comparison to many of the large basins located in Michigan. (See Figure 1.)

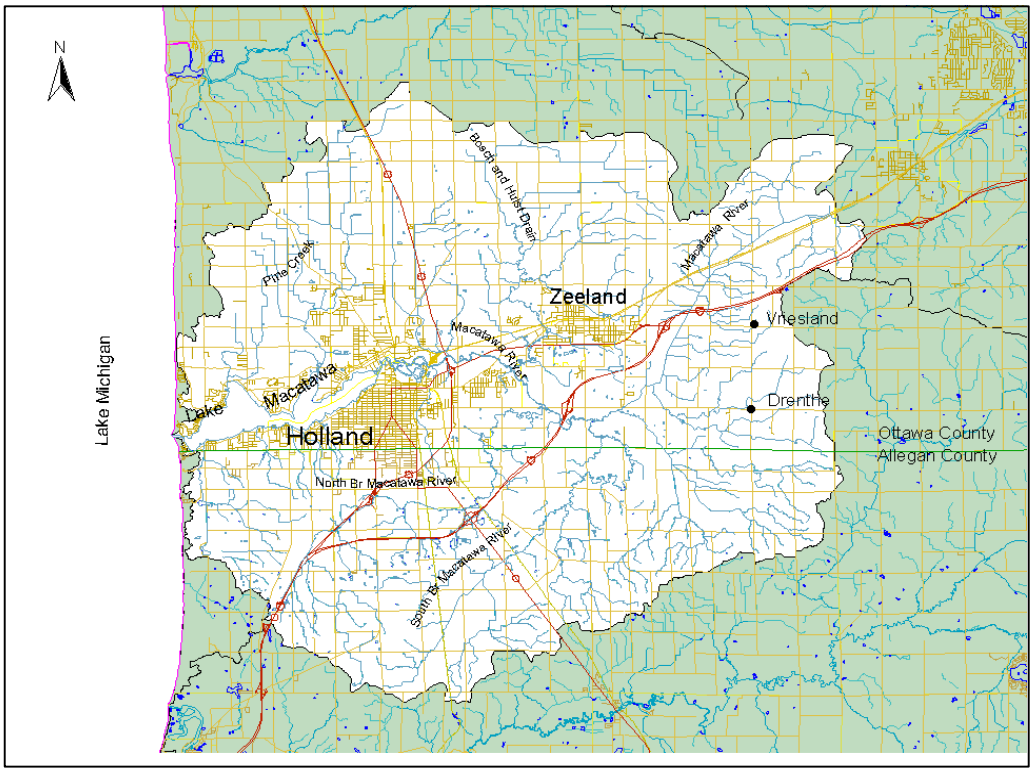

Figure 2. General map of the Macatawa River watershed

The shape of the Macatawa River basin is nearly circular. It is approximately fifteen and a half miles in length from the eastern upper reaches to Lake Michigan. The six main tributaries take shape in the upper reaches of the basin and flow downstream to the central part of the basin to feed the Macatawa River. All but one of these tributaries join the Macatawa River upstream of Lake Macatawa. The Pine Creek tributary enters Lake Macatawa directly. These tributaries, as well as the location of USGS Gage No. 410880, formed the basis of the division of the watershed into 10 subbasins. (See Figure 3 and Table 1.)

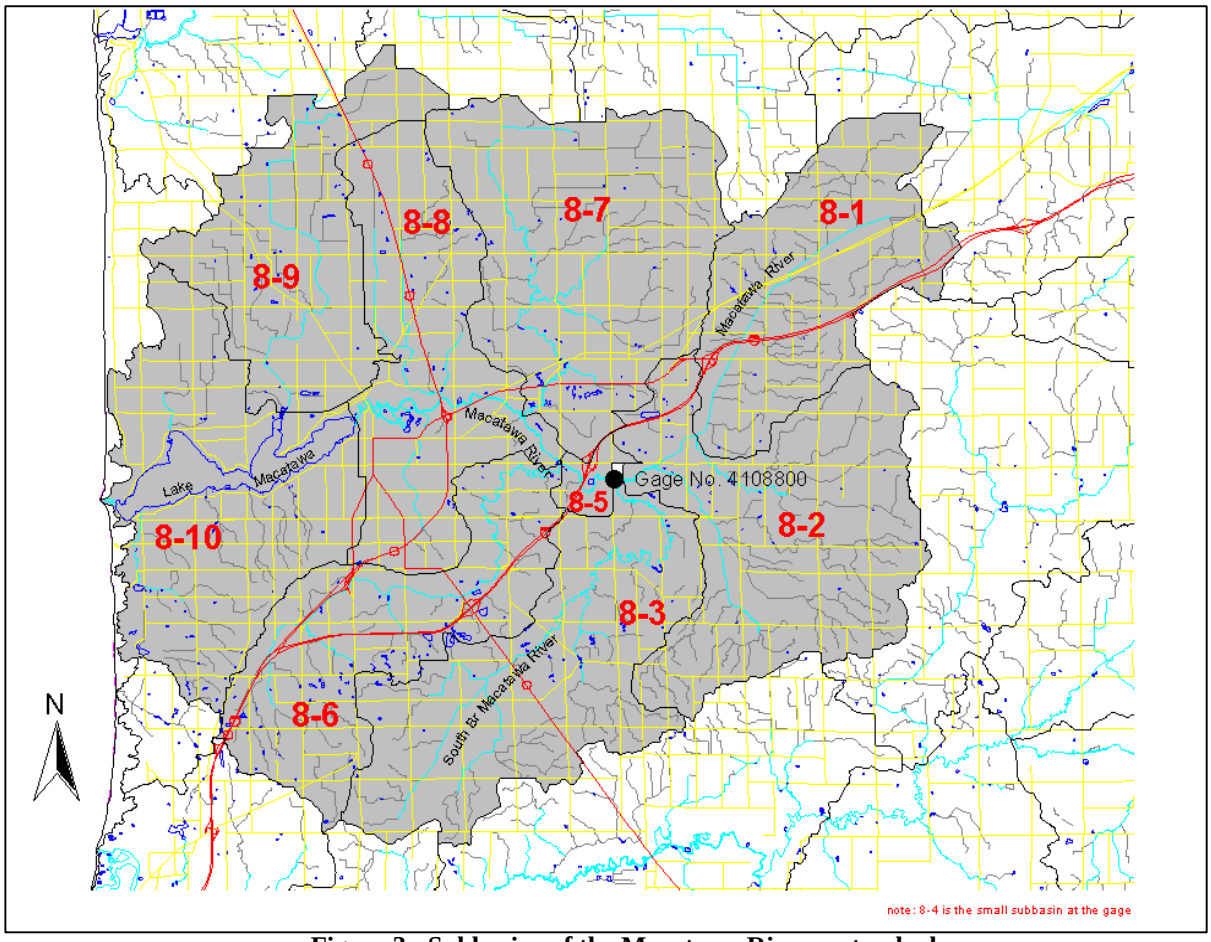

Figure 3. Subbasins of the Macatawa River watershed

Table 1. Names and Drainage Areas of the Macatawa Watershed Subbasins

Subbasin number	Sub-basin name	Drainage area size (sq mi)	Basin outlet
8-1	Upper Macatawa River, 1000 feet East of 84th Street above tributary	18.5	Macatawa River
8-2	Local inflow above S. Branch Macatawa River	24.8	Macatawa River
8-3	S. Branch Macatawa River @ mouth	23.4	Macatawa River
8-4	Macatawa River above gage	0.08	Macatawa River
8-5	Local inflow above N. Branch Macatawa River	1.3	Macatawa River
8-6	N. Branch Macatawa River	18.7	Macatawa River
8-7	Bosch and Hulst Drain	26.1	Macatawa River
8-8	Local inflow above inlet to Lake Macatawa	19.6	Macatawa Lake
8-9	Pine Creek	17.4	Macatawa Lake
8-10	Lake Macatawa	24.2	Lake Michigan

IV. Existing Conditions

The U.S. Army Corps of Engineers' HEC-HMS[1] computer program is used to develop the hydrologic model. The hydrologic model calculates the surface runoff that occurs from a particular storm and routes the runoff through the watershed. A schematic diagram of the watershed, including the main branch of the Macatawa River and major tributaries, is shown in Figure 4. The initial parameter values used for the HMS model are listed in Table 2.

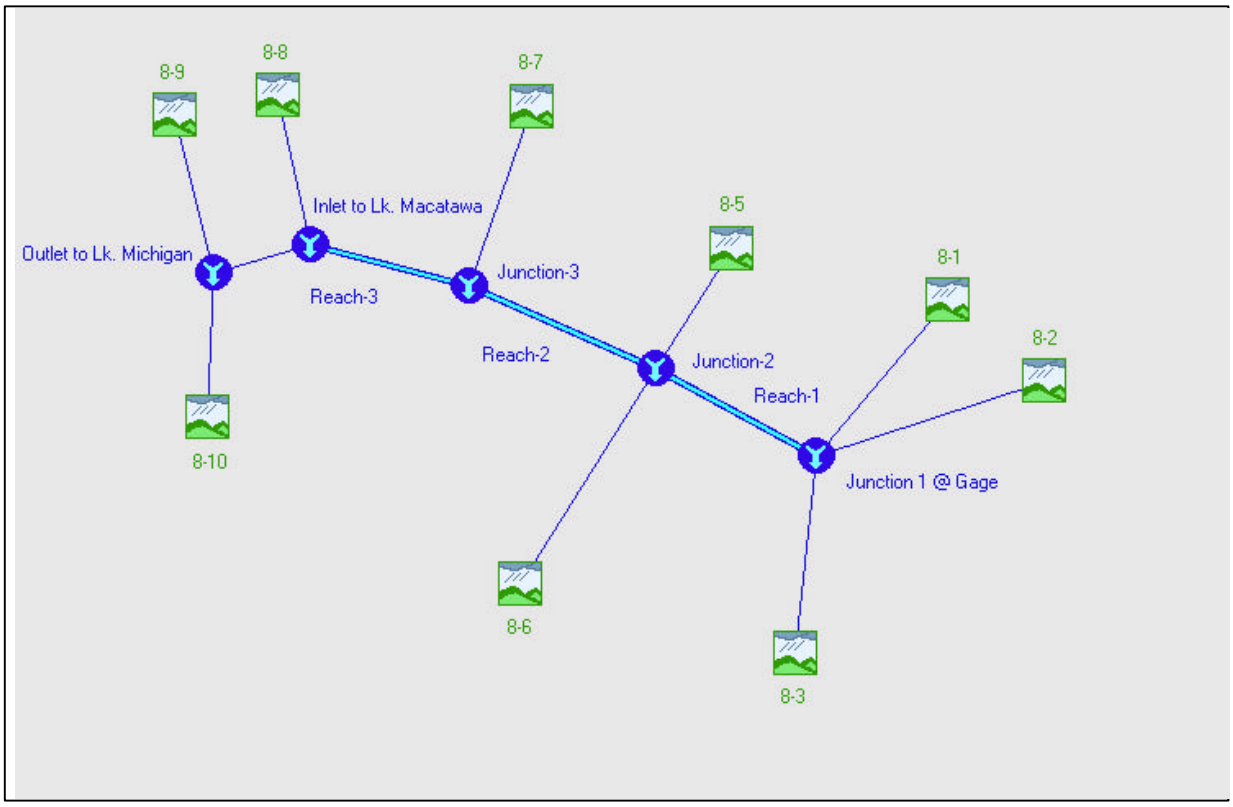

Figure 4. Schematic of the Macatawa River watershed

Table 2. Parameters used in the hydrologic model and their sources

Parameters needed for model	Sources of information	Manipulation required
Drainage areas and watershed delineations	Arc View data files; outlines of Michigan's major watersheds and subbasins with data files including drainage areas and subbasin numbers.	Import into ArcView; isolate to create the Macatawa basin
Curve numbers for subbasins	Soil information: NRCS--SSURGO (Natural Resources Conservation Service--Soil Survey Geographic Database); landuse information from MIRIS/DNR; basin area from subbasin data files.	Add the soil and landuse data into the Macatawa ArcView project. Use the basin and subbasin data to define areas. Manipulate table information and add formulas to generate curve numbers from soil/landuse values.
Time of concentration for each subbasin	Traditional planimeter/digitizer methods for measuring length and reading elevations from USGS topographic maps.	Use SCS-92 methods to calculate time of concentration for the various river reaches.
Baseflow parameters for each watercourse or segment	Standard baseflow values of 1 cfs/sq mi. for initial baseflow; a recession constant of 0.85, and a threshold flow of 0.1, ratio to peak.	Use directly.

Before the model is used to predict hypothetical stream flows, it is calibrated using actual storm events in the basin. The model is calibrated using precipitation and stream data from four major storms. Those floods occurred on the following dates:

May 10-16, 1981
July 16-21, 1982
May 20-29, 1996
June 19-27, 1997

The model is optimized so that the output hydrographs reproduced the observed storm hydrographs as accurately as possible. The model is further adjusted so that the computed discharges for the 10-, 50-, and 100-year precipitation events are similar to those computed by a frequency analysis of the stream gage records. A more detailed description of the calibration methodology is presented in Appendix A.

It is possible to predict flood flows at various locations once the model is calibrated. Floods which are expected, on average, to be equaled or exceeded once every 10-, 50-, 100-, or 500-year period (recurrence interval), are modeled. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year.

The 10-year, 50-year, and 100-year rainfall amounts for this area used in the model are 4.0", 5.5" and 6.0," respectively. These rainfalls estimates are found in "Computing Flood Discharges for Small Ungaged Watersheds" by Sorrell and Hamilton[2]. The model results are listed in Table 3.

Table 3. Predicted discharges for major flood events with current landuse in the Macatawa River watershed

Sub-basin	Location	Area (mi^2)	10-yr flood peak discharge (cfs)	10-yr time to peak (hours)	50-yr flood peak discharge (cfs)	50-yr time to peak (hours)	100-yr flood peak discharge (cfs)	100-yr time to peak (hours)
8-1	Upper Macatawa River	18.5	1300	16.25	2100	16.0	2500	16.0
8-2	Trib. To Macatawa River	24.8	2700	11.25	4500	11.25	5400	11.25
8-3	South Branch Macatawa River	23.5	1600	11.75	2600	16.5	3000	16.5
Junction 1	**Macatawa River** Just downstream of gage #410880	**66.8**	**4700**	**14.5**	**7600**	**14.25**	**8900**	**14.0**
8-5	Local inflow to Macatawa River downstream of gage #410880	1.3	900	6.3	1400	6.5	1600	6.5
8-6	North Branch Macatawa River	18.7	1300	17.0	2100	17.0	2500	17.0
Junction 2	**Macatawa River** Just downstream of N. Branch Macatawa R.	**86.8**	**6100**	**16.0**	**9800**	**15.5**	**12000**	**15.5**
8-7	Bosch and Hulst Drain	26.2	1400	20.25	2300	20.0	2700	20.0
Junction 3	**Macatawa River** Just downstream of Confluence with Bosch & Hulst Drain	**113.0**	**7300**	**17.00**	**11800**	**16.75**	**14000**	**16.75**
8-8	Macatawa River	19.6	1100	16.75	1900	16.75	2200	16.75
Junction 4	**Macatawa River** at the inlet to Lake Macatawa	**132.6**	**8400**	**17.75**	**14000**	**17.5**	**16000**	**17.25**
8-9	Pine Creek	17.4	600	19.0	1100	18.75	1400	18.5
8-10	Lake Macatawa	24.5	1800	12.0	3250	12.0	3900	12.0
Junction 5	**Outlet to Lake Michigan**	**174.5**	**10000**	**17.25**	**17000**	**17.0**	**20000**	**16.75**

*Flows listed at Junction 5 are not accurate as no reservoir routing was used to account for the storage effects of Lake Macatawa.

V. Proposed Flood Control Measures

A stream gage is located on the main branch of the Macatawa River at State Road, just downstream from the confluence with the South Branch of the Macatawa River. Three major subbasins of the Macatawa River watershed are located upstream of the USGS Gage #04108800. More than forty percent of the runoff volume over the entire basin is contributed by these three upper basins and is recorded at the gage. The peak flows of each subbasin are experienced at the gage at approximately the same time, resulting in the largest overall peak discharge possible. Since the upper basins peak around the same time, the intensity of the peak discharge downstream can be reduced if the flow from one of the subbasins upstream of the gage is delayed. One method to achieve such a delay in flows would be to create a flood storage area in one of the upper basins. The hydrologic model can determine how much the peak discharge can be attenuated and whether the amount of attenuation is significant enough to reduce the impact of flooding.

Field inspection of the three subbasins was conducted to find a location for a proposed flood control structure. The goal is to find a location that was situated along the Macatawa River with a drainage area large enough to significantly impact the peak downstream. For example, a drainage area of five square miles contributes such a small percentage of the Macatawa's total runoff volume, that retention of this runoff would have little effect on the flood crest. It is also important that the site chosen for a flood structure be publicly or governmentally controlled by means of ownership or easement rights. The County Road Commission property along the Macatawa River at 84th Street in Zeeland Township appears to be the site with the greatest potential for this purpose. (See Figure 5, Photos A and B, as well as plat map information in Figure 6.)

Photo A. Tributary entering the Macatawa River just possible west of 84th Street

Photo B. Ottawa County property and location for a flood storage area

Note: Cover photo is also a picture of the Macatawa River at the 84th Street Bridge.

Figure 5. Photos related to a flood water retention area in the vicinity of 84th Street

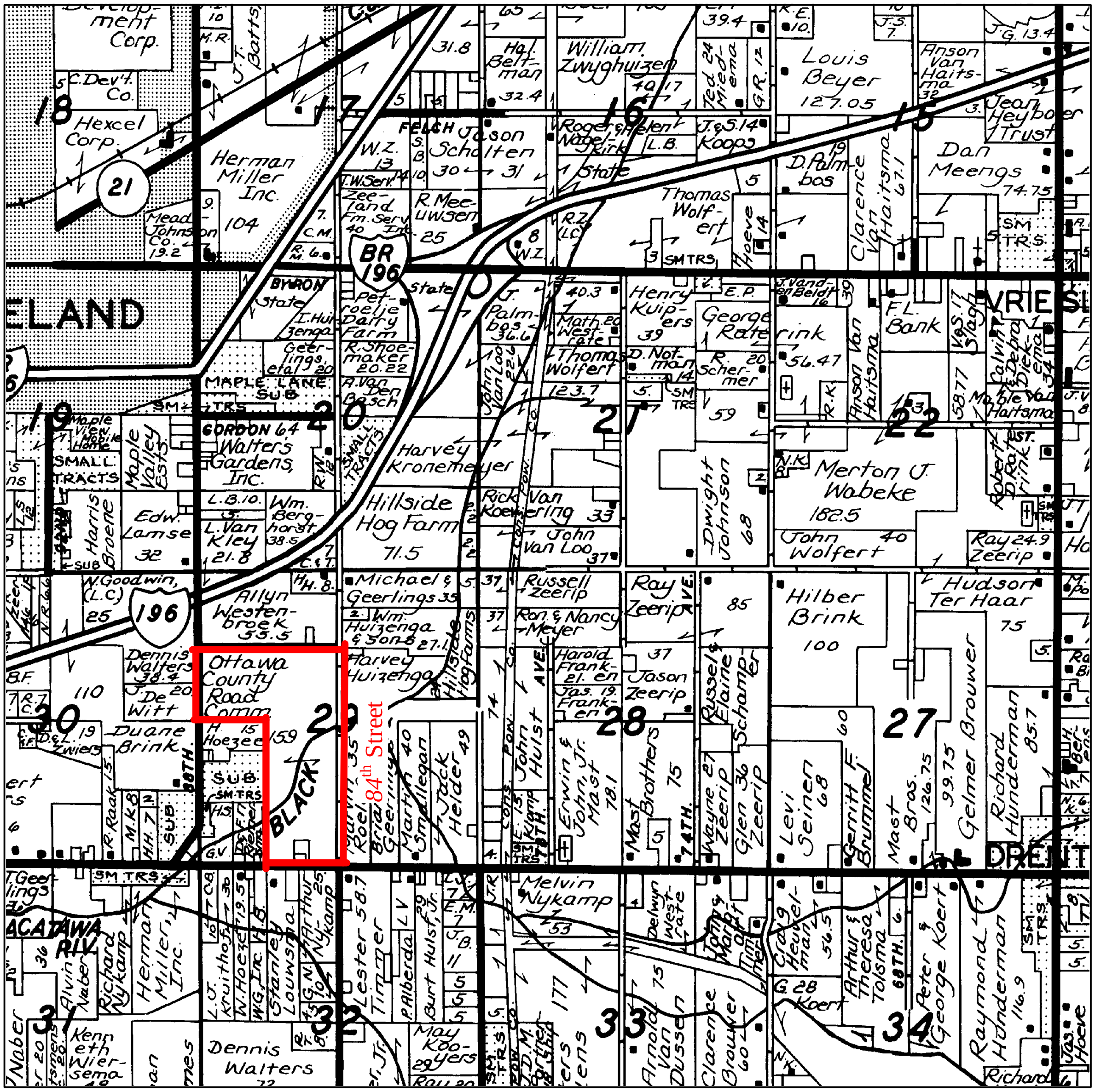

Figure 6. Plat map showing property owners along the Macatawa River near 84th Street

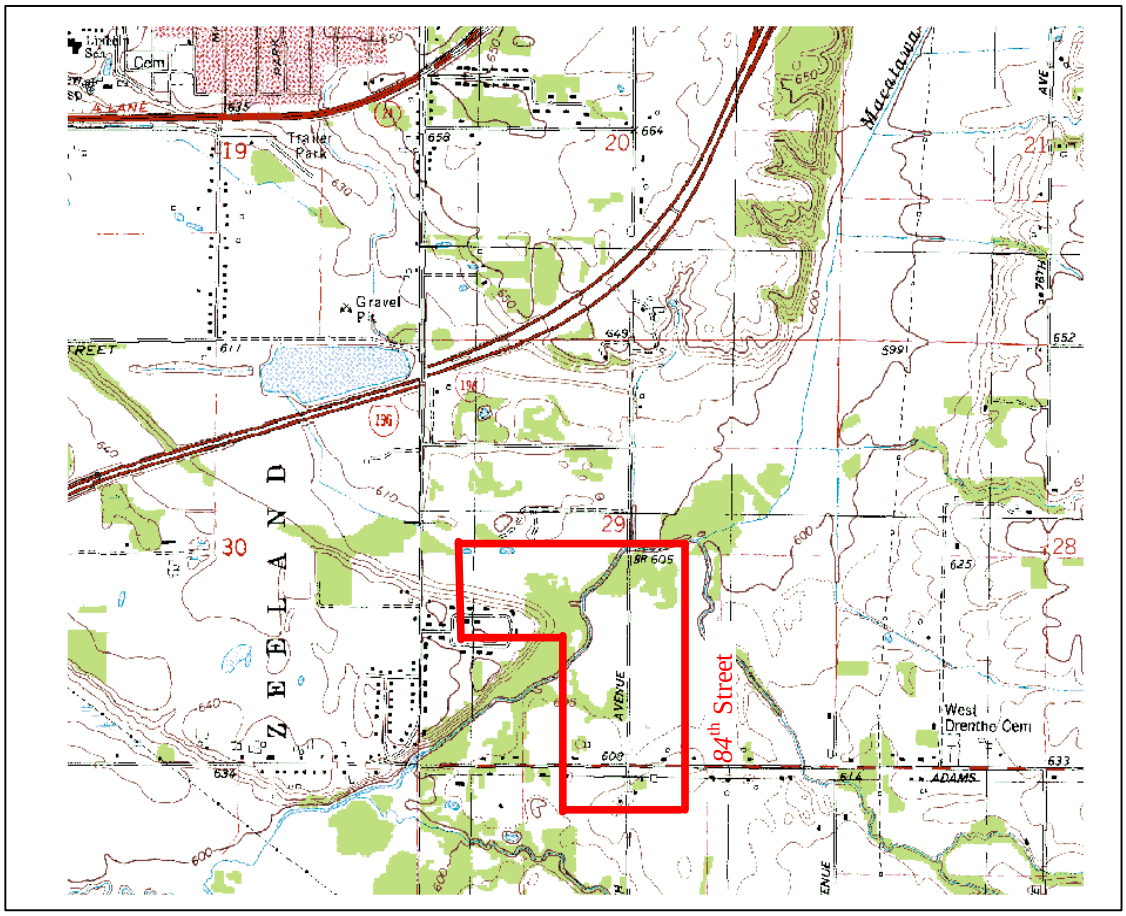

Figure 7. The topography and natural features near the Macatawa River at 84th Street

The drainage area of the Macatawa River at the location of the proposed structure is 28.6 square miles. It includes all of subbasin 8-1 and 10.1 square miles of subbasin 8-2. The subbasin drainage areas in the model are adjusted to accommodate modeling this site. Subbasin 8-1 is changed to include all areas upstream of 84th street (28.6 square miles) and subbasin 8-2 is changed to include the watershed downstream of 84th street (14.7 square miles).

The model is used to determine the base 100-year flood flows for each of the three upper subbasins as well as their junctions using existing conditions, i.e. no flood storage area in place. The hydrograph of the river under existing conditions is evaluated and used to design a diversion of flow to the flood storage area and a routing of the diverted flows back to the river. From the hydrographs (Figures 9 and 10), it appears that if the peak of subbasin 8-1 can be reduced to 2000 cfs, the combined peak discharge of the upper three basins will be substantially reduced. Thus, when the flows in the Macatawa at 84th Street reached 2000 cfs, which corresponds to a specific stage, the flow above that level would be diverted into the flood storage area. The storage area can hold approximately 1000 acre-feet assuming an average depth of 10 feet over

the 100 acres. Flow is routed from the storage area back to the river through a proposed 3-foot culvert. The outflow from this size culvert keeps the retention area from overflowing while simultaneously retaining enough of the flood volume to reduce the downstream crest considerably. See Figure 8 for a schematic of the diversion and flood storage area. Values for the diversion and reservoir routing (from the flood storage area) are found in Appendix B, Tables B1 and B2.

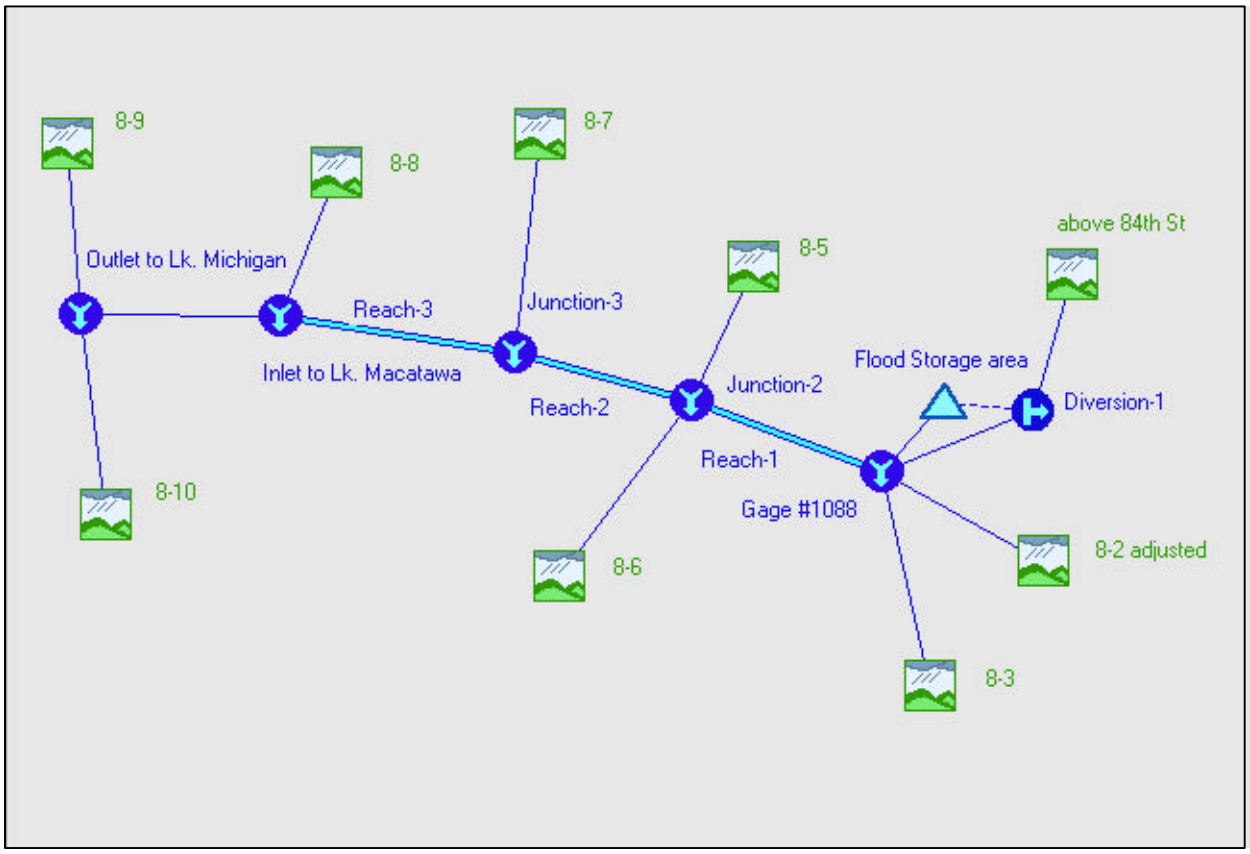

Figure 8. Schematic of the Macatawa River watershed with a diversion of flows to a flood storage area created in subbasin 8-1 in the area of 84th Street

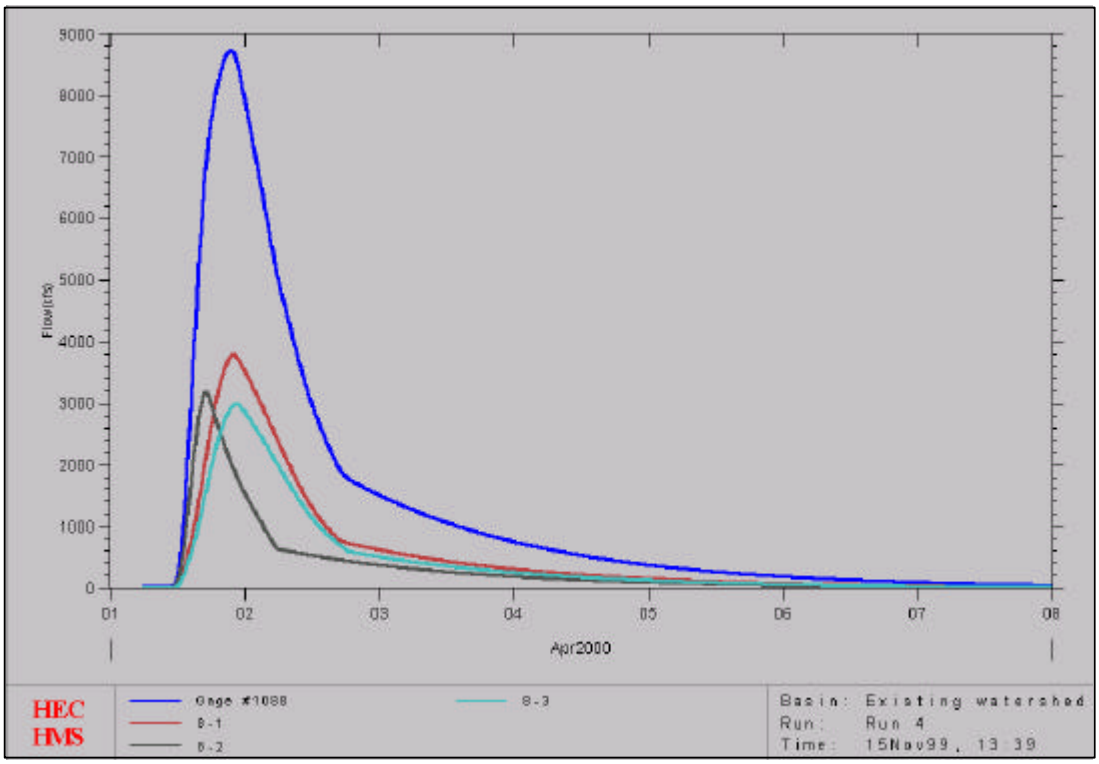

Figure 9. 100-year flood hydrograph for the Macatawa River at the site of the proposed diversion

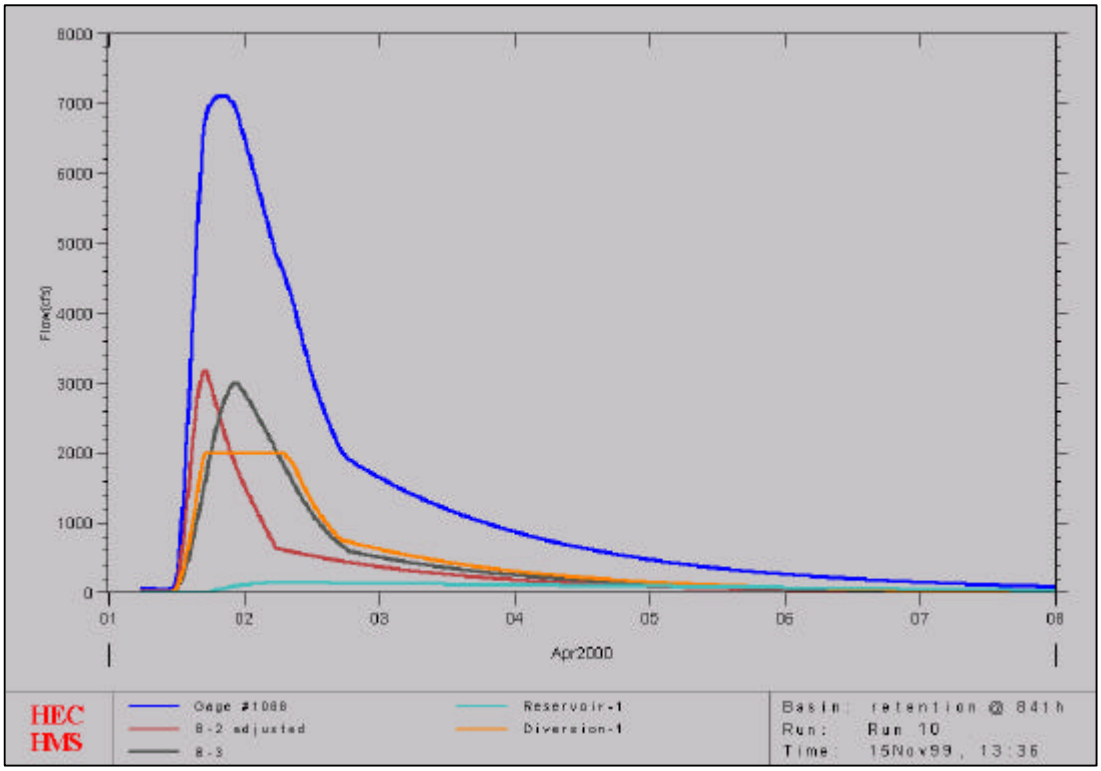

Figure 10. 100-year flood hydrograph for the Macatawa River showing the effect of the flood control area at the proposed diversion site

The model is run with the diversion and flood storage area at 84th Street. Figures 9 and 10 show the hydrographs of the Macatawa River in the area of the gage for a 100-year storm event with and without the flood storage area. The flood storage succeeds in attenuating any flows greater than 2000 cfs at the point of diversion. As a result, the overall peak discharge is reduced by about 1600 cfs. Table 4 lists the expected peak discharges with and without the flood storage area in place along with the resulting flow reduction:

Table 4. Comparison of peak discharge for 100-year storm, with and without a flood storage area in place

Location	Discharge without flood storage (cfs)	Discharge with flood storage (cfs)	Reduction of flow (cfs)
Subbasin 8-1: Macatawa River upstream of 84th St.	3800	Not impacted by flood control measures.	
Subbasin 8-2: Macatawa River upstream of South Branch Macatawa River and downstream of 84th Street	3200		
Subbasin 8-3: South Branch Macatawa River	3000		
Junction 1: Macatawa River downstream of gage	8900	7100	1600 (18%)
Junction 2: Macatawa River downstream of North Branch Macatawa River	11400	9700	1700 (15%)
Junction 3: Macatawa River downstream of confluence with Bosch and Hulst Drain.	13800	12100	1700 (12%)

The model indicates that a 100-acre flood storage area with an average depth of 10 feet created in the County Road Commission property in the vicinity of 84th Street could divert and delay flow, attenuating the peak discharge by 18%. Further down the Macatawa River, in the area of the confluence with the Bosch and Hulst Drain, the peak flows would be attenuated by about 12%.

Another way to analyze the impact of decreasing a storage area on 100-year storm discharges is to compare the hydrologic model results to the discharge and stage predictions found in the Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS). Previous hydraulic modeling of the Macatawa River was conducted in 1988 for FEMA and is available in the City of Holland Flood Insurance Study. Data available in this study included peak discharges, water surface elevations, top width of the channel, and depth at various locations for the 10-, 50-, 100- and 500-year storms. Using these data and the information obtained from the HMS model, it is possible to get a relative idea of the effect that the flood storage area has on flood reduction. Table 5 shows the FIS information for the various storms compared to

the HMS results. A comparison of the discharge data shows that, with a portion of the runoff detained in a flood storage area, the proposed 100-year storm peak discharge is reduced to the current 50-year discharge.

Table 5. Comparison of 1988 FIS hydraulic data with current study

	HMS MODEL RESULTS		FIS HYDRAULIC DATA (EXISTING)			
Flood event	Peak Discharge (cfs) EXISTING	Peak Discharge (cfs) WITH FLOOD STORAGE	Peak Discharge (cfs)	Water Surface Elevation (ft)	Stream Depth (feet)	Top Width (feet)
Junction 1 (FIS Cross section 38135), located downstream of gage 410880						
10-year			4,700	598.12	11.62	860.32
50-year			7,100	599.62	14.12	932.57
100-year	8,900	7,100	8,200	600.35	14.85	991.49
500-year			11,000	602.08	16.58	1204.29
Junction 3 (FIS Cross section 21378) located downstream from confluence with Bosch and Hulst Drain						
10-year			8,000	592.67	16.59	935.11
50-year			12,100	596.28	20.18	960.35
100-year	14,000	12,100	14,000	597.12	21.02	966.32
500-year			18,700	598.87	22.77	978.58

The impact of a flooding event is most easily appreciated by examining the water depth and the width of the floodplain. Reducing peak discharge in a flood event means that the river height is lowered and the flood waters do not reach as far into the floodplain. Table 6 shows that the reduction in the height of the river and expansion into the floodplain is reduced due to the proposed diversion and flood control area.

Table 6. Impact at Junctions 1 and 2 during the 100-year flood due to placing a flood storage area at 84th Street

Location	**Decrease in the peak discharge at each location (cfs)**	**Reduction of floodplain width (ft)**	**Reduction of water depth (ft)**
Junction 1, located downstream of gage 410880	1600	60	1
Junction 3, located downstream from confluence with Bosch and Hulst Drain	1700	6	1

In comparing the two junctions in Table 6, it is clear that various locations are impacted to different degrees depending on the local topography. For instance, the typography of the cross section at Junction 1 is flat and allows for water expansion into the floodplain as the river height increases. In comparison, Junction 3 is

constrained by topography and there is less floodplain area for the flood waters to expand into even with the same reduction in water depth. As a result, some locations significantly benefit from reducing peak discharges during a storm while others may see little benefit from the flood storage area in terms of the reduction in floodplain width. All areas show a consistent one-foot lowering of the 100-year floodplain elevation. This can be further assessed through detailed, hydraulic modeling of the watershed.

VI. Buffer Areas

Buffer areas consist of the land adjacent to a watercourse or water body that is vegetated with trees, shrubs, and groundcovers. The plants and trees in buffer areas reduce and filter runoff through interception and surface detention. They also help to slow down runoff, enabling it to filter into the ground more easily. Less runoff reaches the river, reducing the volume that contributes to the flood peak. The soil acts as a filter, removing excess nutrients and pollutants and trapping sediments. Plant materials also stabilize stream slopes to help prevent erosion. Buffer areas along a watercourse contribute to improved water quality and can reduce runoff volume.

The identification of existing buffer areas throughout the Macatawa basin is one of the goals of this study. GIS applications are ideal for performing such a task, matching land use data with geographic features like rivers. For this project, the types of land use that function as a buffer, such as forests, meadows and wetlands, are obtained from the MIRIS/DNR land use information.

A buffer zone, i.e., the area where buffer land use should ideally be located, is also identified using the hydrography information for the watershed and locating the limits of the zone 100 feet from both sides of the watercourses. Table 7 shows the buffer areas recommended in "The Buffer Handbook" developed through the State of Maine Department of Environmental Protection. It is reasonable to define the buffer zone relative to the normal high-water mark using a setback ranging from 75 to 100 feet. A setback of 100 feet is chosen because it is a typical distance for this type of buffer zone.

Table 7. Standards for buffer area setbacks from the normal high water mark of the water

Setback from the normal high water mark	Type of water body
100 feet	Lakes
100 feet	Ponds greater than 10 acres
75 feet	Other waterbodies, streams or wetlands

Land use that acts as an appropriate buffer within the buffer zone is identified in Figure 11. In most of these segments the full extent of the buffer zone, from the water's edge to the limit of the setback, is vegetated. However, there are some areas of the buffer zone where only a portion of 100-foot setback contains a vegetative buffer. About 30% of the length of all the watercourses in the watershed contains some degree of buffering with most of it being central hardwood forest. Table 8 shows the types and percentage of land use in the buffer zone that currently serves as a buffer for runoff in the waters of the Macatawa basin.

Table 8. The type of buffer land within 100 feet of the Macatawa River and tributaries

Land use	**Per cent of Buffered Land**
Shrubland	1.5
Shrub/scrub wetland	5.6
Outdoor recreation	3.2
Lowland Hardwood	12.5
Herbaceous	2.3
Pine	2.7
Emergent Wetland	0.4
Central Hardwood	71.5
Aquatic Bed Wetland	0.1
Wooded Wetland	0.2

The Macatawa Watershed Project report[3], a study concerning phosphorus reduction performed by the Macatawa Area Coordinating Council in 1998, recommends enhancing the buffer areas along local watercourses and adding additional vegetative strips wherever possible. The report identifies erosion and phosphorous loading of the Macatawa River as specific problems. It proposes imposing a voluntary phosphorus limit as a nonpoint source pollution reduction goal. Achieving this goal requires the implementation of various land use and management practices such as improving the buffer areas along the watercourses. The report also points out that since 70% of the land use of the Macatawa Watershed is agricultural, farmers should play a greater role in this endeavor. Figure 11 shows the location of the agricultural areas relative to the unbuffered segments of the rivers.

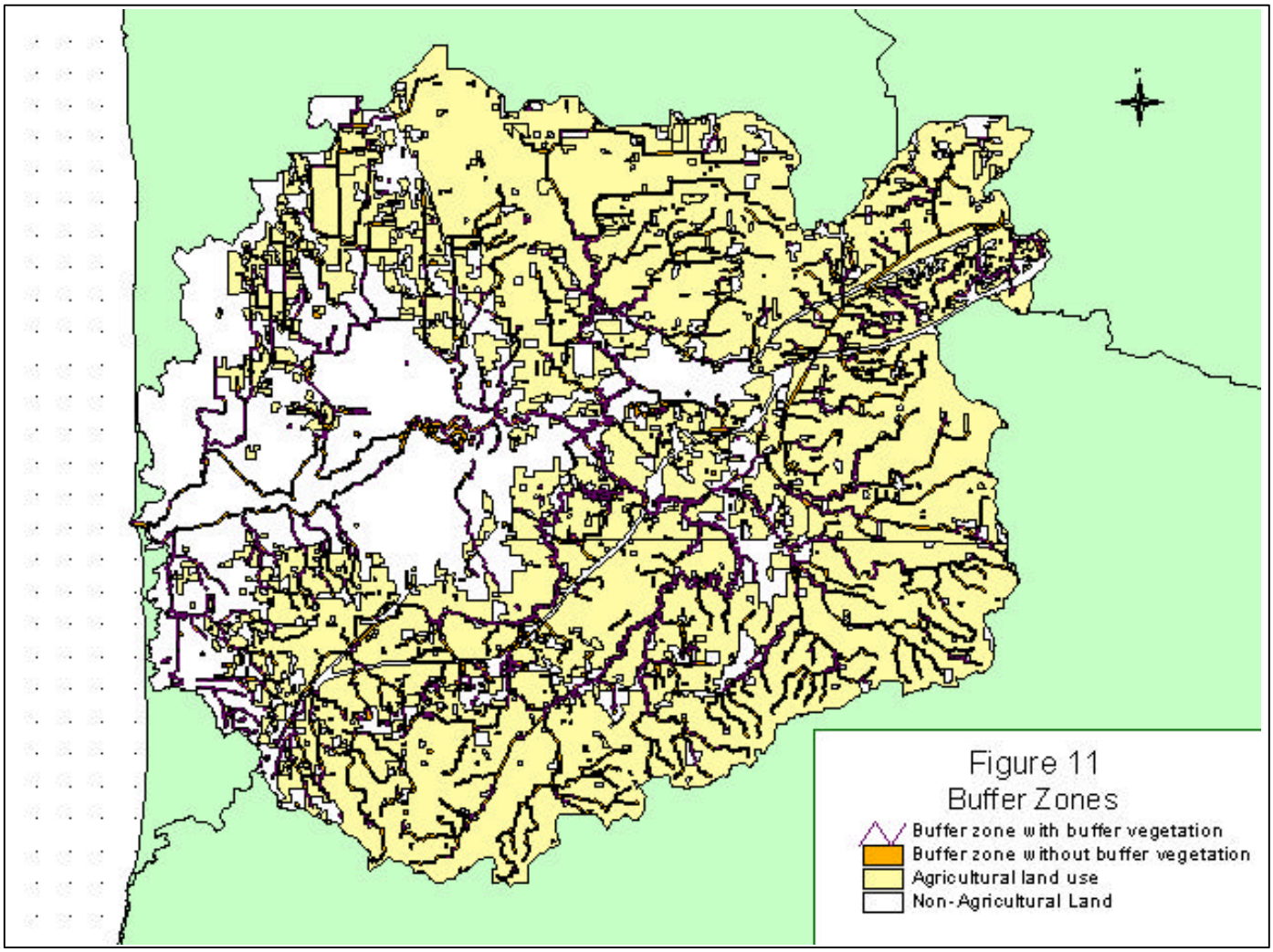

Figure 11. Buffer zones and buffer areas along the Macatawa River

(Contact the number on page 19 if you would like a larger, more detailed version of this map.)

VII. Summary

Flooding causes major problems in the Macatawa Watershed. The largest floods occurred in 1981, 1982, 1996, and 1997. The MDEQ conducted this study in order to evaluate ways to minimize the impact of the floodwaters on persons and property in this area. One of the goals of the study is to look at the possibility of using a flood storage area somewhere in the basin to retain water during flooding events to attenuate the peak discharges and lower the crest. Buffer zones are also evaluated with regard to the amount of existing buffer area and its location throughout the basin.

A hydrologic model is used to predict peak discharges at various sites throughout the watershed for major flood events. The evaluations are first made for the basin with its existing configuration and land use. Next, a proposed 100-acre flood storage reservoir is added to the basin model. This reservoir is located on the main branch of the Macatawa River in the area of 84th Street in Zeeland Township.

The model demonstrates that a flood storage area of this size would reduce the impact of a 100-year storm to what is now experienced by a 50-year storm. The river's crest could be reduced by one foot and the expansion of the flood waters into the floodplain could be reduced by 60 feet or more in some areas.

This preliminary study on flood control measures indicates that further exploration of this subject has some merit. The additional work should include a hydraulic analysis of the watercourses in the basin during major flooding events. Flood storage should be included in the analysis to evaluate stage reduction throughout the basin. This information could be used to generate floodplain maps in conjunction with available information on existing structures and sites prone to flood damage. GIS methods would be ideal for this work using digital elevation maps for the specific areas of flood coverage, superimposing elevations and floodplains on maps including structures to identify areas that could potentially be damaged by flooding. An economic evaluation should be performed to compare the costs of developing flood storage areas to the economic impact of flooding events. The economic analysis would also be useful in determining the feasibility of buying out or rehabilitating any flood prone sites if FEMA funds become available.

An initial identification of buffer areas also shows that 70% of the riverfront is not currently buffered in any way. These are areas where property owners can be encouraged to plant vegetative strips.

There are a number of measures that can be used to reduce the impact of flooding and improve water quality. The area has already received much attention and study and local communities have demonstrated interest in taking responsibility to protect and improve the watershed. There is every reason to believe that much can be accomplished if the communities and related groups and agencies work together.

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[1] Hydrologic Modeling System (HEC_HMS), Version 1.1, 1999. Hydrologic Engineering Center. U.S. Army Corps of Engineers.

[2] Sorrell, R.C. and Hamilton, D.A. 1991. Computing Flood Discharges for Small Ungaged Watersheds. Michigan Department of Natural Resources Land and Water Management Division. Lansing, MI.

[3] Higgins, S. and Kosley, K. 1998. The Macatawa Watershed Project. Phosphorus Reduction Strategy for the Macatawa Watershed. Macatawa Area Coordinating Council. Holland, MI.

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The Water Management Section (WMS) of the DEQ's Land and Water Management Division provides the public and other governmental agencies with data related to Michigan's watercourses. Included in this data are flood volumes, flood elevations, drainage areas, low flow volumes, and stream gage information. The information is used by others for engineering design work as well as "in house" for performing evaluations of watersheds and watercourses. The Nonpoint Source Grant for this project enabled the Section to improve its GIS and modeling capabilities, thereby upgrading data sources, methods, and personnel expertise that will be beneficial for other future studies of this nature.

Appendix A – Calibration Data

Calibration. The watershed model was calibrated using precipitation data from four major storm events and the observed stream gage data recorded at the time of these storms. The rainfall data was obtained from the National Oceanic and Atmospheric Administration (NOAA). The hourly data of the Grand Rapids, Kalamazoo, and Allegan precipitation gages were used to approximate the rainfall distribution for each of the four storms based on the storm direction. The Holland daily precipitation amounts were used to estimate the total rainfall for each storm upstream of the USGS Gage #04108800 located five miles west of Holland. The Holland total was used with the hourly rainfall curve. This method for obtaining the rainfall distribution at Holland was used because there was no hourly precipitation data available.

The initial parameter values, such as time of concentration and curve number, were adjusted until the model discharge volumes and the observed discharge volumes were the same and the model and observed hydrographs visually appeared similar. The optimal parameter values used for the four storm events were similar but not exactly the same, as would be expected, so the curve numbers, times of concentration, and storage coefficients were averaged to establish initial calibrated parameters.

The initial calibrated model was then used to generate peak flows, time to peaks, and volumes for the 10-, 50-, 100-, and 500-year (statistical) storm events. Rainfall-duration values were taken from the Type II rainfall distribution. The 10-, 50-, 100-, and 500-year rainfall amounts were obtained from rainfall maps in the MDEQ's publication, "Computing Flood Discharges for Small Ungaged Watersheds."

Final adjustments were made to the parameter values so that the results could be used in the Log Pearson analysis. Table A1 lists the output from the calibrated model for the various observed and statistical storms. Since the calibrated model was adjusted to best characterize all of the storm events, no specific event will be represented exactly.

Table A1. Gage and precipitation data

OBSERVED DATA (PRECIPATION AND GAGE)							
Date of Storm	**Storm Direction From**	**Hourly Precipitation Gage Used**	**Precipitation**			**Peak Discharge**	
			Hourly Gage	**Holland Gage**	**Used in HMS Model**	**At gage #0410880 (cfs)**	**From HMS model (cfs)**
May 10/11, 1981	West	Grand Rapids	6.5”	5.04	6.5	7200	6924 (CN=70)
July 17, 1982	Northwest	Kalamazoo	5.2”	8.0	5.8	4600	6904 (CN=66)
May 20, 1996	West	Grand Rapids	3.2”	4.3	4.3	4300	5760 (CN=79)
June 20, 1997	Northwest	Allegan	6.0”	4.9	4.9	8800	10271 (CN=77)

HYPOTHETICAL STORM EVENTS				
Storm Frequency	**Expected Rainfall Amounts**	**Log Pearson Discharge Estimates (cfs)**	**HMS Discharge Estimate (cfs)**	**Time to Peak from beginning of rainfall**
10% Frequency – 10-Year Flood	4.0”	4900	4700	14.5
2% Frequency – 50-Year Flood	5.4”	7800	7600	14.25
1% Frequency – 100-Year Flood	6.0”	9200	8900	14.0
0.5% Frequency – 200 Year Flood		11000	10000	14.0

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Table A2. Final parameters used in the Macatawa basin model after calibration

Basin ID	Curve Number CN	Time of Concentration t_c (hours)	Storage Coefficient R (hours)
8-1	79	10.5	9.4
8-2	78	5.5	4.9
8-3	79	11.0	9.9
8-4	83	2.6	2.3
8-5	83	0.7	0.6
8-6	81	11.4	10.2
8-7	79	14.6	13.1
8-8	75	11.1	10.0
8-9	68	12.9	11.6
8-10	72	6.2	5.6

Precipation
May 10/11, 1981
(NOAA)

Holland Rainfall: 5.04”

date	**time**	**hourly rainfall (Grand Rapids)**
5/10/81	1:00	0.01
	2:00	0.02
	3:00	0.05
	4:00	0.12
	5:00	0.1
	6:00	0.04
	7:00	0.1
	8:00	0.19
	9:00	0.21
	10:00	0.2
	11:00	0.21
	12:00	0.14
	13:00	0.26
	14:00	0.13
	15:00	0.18
	16:00	0.17
	17:00	0.13
	18:00	0.17
	19:00	0.14
	20:00	0.19
	21:00	0.21
	22:00	0.16
	23:00	0.21
5/11/81	0:00	0.19
	1:00	0.25
	2:00	0.24
	3:00	0.2
	4:00	0.48
	5:00	0.43
	6:00	0.39
	7:00	0.31
	8:00	0.28
	9:00	0.2
	10:00	0.2
total		6.51

Precipation
June 16/17, 1982
(NOAA)

Holland Rainfall: 8.0”

date	**time**	**hourly rainfall (Kalamazoos)**
7/16/82	20:00	0.1
	21:00	0.1
	22:00	0.1
	23:00	0.1
7/17/82	0:00	0.1
	1:00	0.1
	2:00	0.1
	3:00	2.8
	4:00	1.4
	5:00	0.3
total		5.2

Precipation
May 20, 1996
(NOAA)

Holland Rainfall: 4.29”

date	**time**	**hourly rainfall (Grand Rapids)**
5/20/96	0:00	0.04
	1:00	0
	2:00	0
	3:00	0.02
	4:00	0.04
	5:00	0.06
	6:00	0.09
	7:00	0.02
	8:00	0.07
	9:00	0.03
	10:00	0
	11:00	0
	12:00	0.55
	13:00	0.86
	14:00	0.24
	15:00	0
	16:00	0.02
	17:00	0.02
	18:00	0.59
	19:00	0.3
	20:00	0.13
	21:00	0.05
	22:00	0.03
total		3016

Precipation
June 20, 1997
(NOAA)

Holland Rainfall: 4.9”

date	**time**	**hourly rainfall (Grand Rapids)**
5/10/81	11:00	0.00
	12:00	0.30
	13:00	0.20
	14:00	0.00
	15:00	0.00
	16:00	0.00
	17:00	0.00
	18:00	0.00
	19:00	0.00
	20:00	1.10
	21:00	2.40
	22:00	0.90
	23:00	1.00
	0:00	0.10
total		6.00

Appendix B - Flood Storage Area

Table B1. Specifications for diverting stream flow from the Macatawa River to a storage area at 84th Street

Inflow (cfs)	Diverted Flow (cfs)
1020	0
1265	0
1540	0
1840	0
2180	180
2550	850
2960	960
3400	1400
4400	2400
5000	3000
5500	3500

Table B2. Specifications for routing flows from storage area back into Macatawa River

Storage (acre-feet)	**Outflow (cfs)**
0	0
100	44
200	62
300	76
400	88
500	99
600	108
700	117
800	125
900	132
1000	139
1100	146
1200	152

Appendix C – *Holland Sentinel* Articles

MAY 10/11, 1981 STORM

Floods follow 5 inches of rain

More than five inches of rain since 4 a.m. Sunday left streets flooded, cars stalled, rivers and streams swollen to near flood stage, and fields and drainage ditches indistinguishable today in Ottawa and Allegan counties.

Flood watches were issued for the two counties.

The flash flood warning was canceled by the weather bureau at noon today.

The Holland Fire Department and street department officials sandbagged one home in Holland.

Flood warnings were issued for Fennville by the National Weather Service in Ann Arbor. Street crews in Fennville said roads were about six inches under water this moring but were open to traffic. "Our city streets are gone. We can't find them," clerk Dorothy Garlock said.

Scores of Ottawa County Civil Defense volunteers from Holland, Zeeland, Allendale, Georgetown and Hudsonville were activated to assist police and deputies in traffic control.

Civil Defense supplied sandbags for a home at 661 Apple Ave., owned by Jake Bakker. About 7:45 a.m. a basement wall caved in. Water was reported one-foot outside the building and four feet in the basement.

Zeeland Public and Christian schools were closed today. Water reportedly covered the high school's auxiliary gym and other portions of the school had water on the floors and the architect has been called to the scene.

According to Leon Van Harn, Zeeland city superintendent, Paw Paw Drive between Chicago Drive and 104th Avenue was closed because the wing walls on the bridge that crosses the north branch of the Macatawa River fell in. Without the concrete structures on the edge of the bridge, the road shoulders faced erosion, Van Harn said.

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Other than that, there hasn't been anything "we've not been able to handle," Van Harn said. The "100-year rain" has caused all of the sewer lift stations to be flooded out, causing numerous flooded basements.

Meanwhile, local law enforcement agencies report more roads were closed and deputies in Grand Haven joked "We're all building arks."

Counties under Flash Flood Watch issued this morning by the National Weather Service include Allegan, Ottawa, Muskegon, Van Buren, Cass, Montcalm, Ionia, Barry Calhoun, St. Joseph, Gratiot, Clinton, Eaton, Jackson, Branch, Saginaw, Shiawassee, Ingham, Hillsdale and Kent.

In Kent County where flood warnings have been issued, at least 19 roads were completely blocked and under more than a foot of water, sheriff's deputies there said.

The weather service cautioned to be alert for washed-out roads, saying the heaviest rainfall appeared to have occurred in Kent, Ottawa, Allegan, Kalamazoo and Van Buren counties.

Some, but not all the roads reported underwater this morning included:

Allegan County — intersections at Old Allegan Road and 63rd Street, 133th Avenue and 60th Street, 134th Avenue and 58th Street, 53rd Street and 136th Avenue, near Fennville, 118th Avenue and 64th Street, 48th Street south of M-89 and 56th Street south of 108th Avenue. "Sixty-fourth Street north of Saugatuck is completely washed out. There's no road at all," deputies said.

Ottawa County — intersections at U.S.-31 and New Holland Street, Quincy Street and Riley Street. Deputies report M-21 and Port Sheldon Road was closed as was Chicago Drive from Zeeland to Hudsonville. Quincy and Greenly Streets were reported to have standing water from six inches to one foot. Ninety-sixth Avenue at the Quincy Street and James Street intersections was under two feet of water.

In Holland City, the Blue Star Highway-South Washington Avenue-U.S.-31 intersection was closed due to high waters. Other streets underwater include Pine Avenue near the power plant, Van Braght Park, 17th Street and Ottawa Avenue, and 16th Street. Many streets were reported underwater.

Also reported under water was Chicago Drive at 112th Avenue intersection and Ninth Street at Garretson Street.

Area grain farmers were a little disappointed about the weekend's heavy rains.

While the extra moisture would have been welcomed either several weeks ago or a few weeks from now, its timing was bad for most farmers. Plowing was just getting a good start late last week when the weather changed Saturday night.

It is not too late for planting yet, but there was so much rain that many fields now have standing water and will take as much as a week to dry out even if no more rain comes.

Motorists urged to watch for washouts along roads

Holland city streets came out pretty well following the torrential rain Sunday and Monday which dumped up to five inches of rain, according to city engineer Gordon Heidenga.

"Basically we came off pretty well," he said. "It could have been a lot worse," he said.

However, he said, Holland did sustain some damage and many roads were temporarily washed out. The Paw Paw Drive bridge will remain closed until the Macatawa River recedes enough to allow inspectors to check under the bridge.

He reported that there are several washouts on Paw Paw Drive because of high waters.

In addition, he said 24th Street between Waverly Road and Country Club Road was washed out.

Police of the Saugatuck State Police Team report that half of 140th west of 64th Street is gone. The "gully" caused by eroding waters was expected to be filled today by the Allegan County Road Commission.

In Ottawa County, road commission Engineer Ronald Bakker said the state trunk lines were open but many graveled side roads were washed out. In some cases the culverts have been washed away.

He said road crews were repairing 120th Avenue near the bridge. He said high waters had washed out the bank under the pavement. Ninety-sixth Avenue south of 16th Street near the creek also sustained similar damage when high waters washed out the pavement's foundation.

Road crews are "busy pecking away" at the damage, Bakker said.

Zeeland High School was dealt an easterly blow of six inches of rain which caused about $2,000 to $3,000 worth of damage.

The damage occurred where the 1957 section and the 1978 editions joined. The damage apparently stemmed from the strong northeasterly winds. Superintendent of Zeeland schools Dr. Ken Harper said that there has been no damage from major storms out of the west or south.

Two locations in the business department suffered some ceiling tile damage which fell down on some textbooks and some water fell on some business equipment. Dr. Harper said it was minor in nature.

The auxiliary gym floor is believed to have suffered no damage because maintenance personnel kept the area mopped up.

The architects, Dayerman and Associates and the general contractor, Vander Werff Construction and Company were on the scene inspecting the damage with school administrators after the storm.

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A-3

Meanwhile, the hardest hit area in Zeeland was 104th Street and Alice Avenue. Many residents had water in their homes. Hundreds of homes in Zeeland had water in their basements.

Leon Van Harn, city superintendent, said the basement water was caused by the water table being so high, it seeped through the basement walls and the sewer system backing up throught he drains.

Van Harn reports there was no problems with the lift stations. "They just couldn't keep up with the flow."

Zeeland's emergency services worked all day helping to sand bag and pump out basements and with traffic control. In some areas the Macatawa River was a quarter mile wide and there was still a lot of standing water. Crestwood Village Condominiums had a lot of flooded basements.

By The Associated Press

Workers were busy today cleaning up the damage left by flash floods that swept across southern Michigan, closing dozens of roads, forcing the city of Grand Rapids to dump raw sewage into a river and stranding at least two renters on the roof of their apartment complex.

Although in most areas the worst of the flooding came Monday, at least one river was not due to crest until today, the weather service warned. The Rogue River was scheduled to reach flood stage early today near Rockford, north of Grand Rapids, according to hydrologist Gary Charson.

In Kent County, at least 40 roads were due to be closed today because of washouts or inaccessible bridges, said Lt. William Dice of the Kent County Sheriff's Department.

JULY 17, 1982 STORM

Storm slams Holland

By Sentinel staff writers

A massive thunderstorm deluged the Holland area this morning with more than eight inches of rain causing power outages, closing roads and and major flooding in the city.

This morning most major thoroughfares leading outside of the city were impassable because of heavy flooding. Road crews were setting up barricades and city police officials said the roads would be impassable until later in the morning.

The splash of thunder and lightining lit up the sky for most of the evening and police unofficially estimated the rain fall at about eight inches.

The storm knocked out Holland Board of Public Works substations, and downed primary and secondary power lines, said Gord Schrotenboer, controller for the BPW.

The Mayrose area on the north side and the tail end of Waukazoo Woods was still without power this morning, said Mike Trethewey, storekeepr for the BPW.

Trethewey said there would still be scattered outages for awhile.

Schrotenboer said most electricity was back on except in those areas on Fairbanks and near the Wharf Restaurant where basements were flooded and electricity disconnected for safety reasons.

Schrotenboer said all crews were out and would be working a good share of the day but had no estimate on when things would be back to normal. He didn't know of any problems with sewers backing up.

Water from the storm flooded out all the basemments along 24th Street between Lincoln and Fairbanks and caused three gas leaks, according to Ottawa County Emergency Serivces Director Thomas Caldwell.

Two residents reported their basement walls had caved in.

Emergency services logs showed activity in the emergency services office began at 2:47 a.m. Saturday.

Sometime shortly after 8 a.m. today a resident located on Mason Street between 104th and 112th reported a washout of property.

Several roads proved impassable. The junction of 8th Street and Chicago Drive was flooded as were streches of 16th and 24th Streets. Caldwell reported 24th Steet was "hit the hardest."

He also reported a car sank at the junction of M-40 and U.S.-31. The passengers were forced to swim to the curb.

Holland Police said the only way out of town was through northbound US 31 which is closed south of 32nd Street.

Other major roadways closed this morning include Eighth Street, east of Lincoln Avenue; 16th St. east of U.S. 31; Blue Star Highway interchange; and M-21.

Caldwell reported his office was unaware of any weather-related injuries.

The Holland Fire Department made 13 weather-related emergency calls throughout the morning but reported no fires.

A weather-related fire occurred at Ottawa Door Light in Zeeland but no further information was available this morning.

Fire units also responded to the scene at Montgomery Wards where the roof caved in, but no fire was reported.

Lightning complicated matters for emergency services people, knocking out telephone lines and the citizens band radio.

"We got hit hard. We had a flash-like arcing condition."

A transformer either started on fire or was arching at Holland Township fire station #1, Caldwell said. Holland police also reported their office was struck by lighting, shorting out the air conditioning.

Bob VandenBerge, a flight instructor at Tulip City Airport said a third of the runway was under water but said some small planes could come in.

Ed Hunt, park ranger at Holland State Park reported some standing water in the Lake Macatawa unit. He said there were power outages at the park but he had no reports of lighting hitting the park.

The Holland Coast Guard reported being called out on five rescue calls which kept crewmen busy until 6 a.m. A spokesman for the Coast Guard said one boat was capsized and in another incident two people were pulled from the seawall on Lake Michigan. A few other boats were stalled in a drift in the waves which varied from four to eight feet. The rescue work was slowed, he said, because of poor visibility and rain.

In Hamilton, 72-year-old Susan Smit was traveling northbound along M-40 north of 48th Street at about 5 a.m. when her car left the roadway, landed in a ravine and submerged in about 6 feet of water.

Allegan County Sheriff's deputies said Mrs. Smit crawled out of the car's side window and was not injured. Deputies said, though, the woman was shaken up in the ordeal.

Deputies said M-40 and M-89 are passable, but were advising motorists this morning not to travel on them. They said road crews will begin repairing damaged portions of the road this morning.

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Many residents lack insurance

By Sentinel staff writers

Many private homeowners are not insured against the water damage resulting from Saturday morning's torrential rainfalls, several Holland area insurers said.

Flood damage is not included in comprehensive insurance policies such as the homeowner's policy. There is, however, a federal flood program that is underwritten by the federal government. But insurance companies don't sell many of these policies.

The main reason for this seems to be that homeowners don't think the insurance is necessary. Floods in the Holland area are rare, and most Holland area houses are not in a high-risk flood plain. Next to that, flood insurance is expensive and has a high deductible.

Insuring a ten-year-old $50,000 two-story house that is not in a dangerous area can cost as much as $160 a year. Additional insurance for the contents of the house can add another $50 to the bill. On top of that, both policies will have at least a $500 deductible each. Though these figures may vary from house to house, they provide an indication of the cost involved in insuring against flood.

"It's worth it when it happens, but only then," Dale Van Lente of Holland Insurance Agency said, adding that few flood insurance policies are ever sold.

The government insurance program started more than a decade ago because most private insurers were wary of the risks involved in insuring against floods. Insurance companies work with homogeneous exposure units, groups of insurance-takers that are essentially in the same risk group. With flood insurance, such a group is hard to find. "Everyone is a rating case in its own," Van Lente said.

Added to that is the fact that flood insurance is not a very profitable business for an insurer. As Bob Wolbrink Jr. of Wolbrink Insurance explains: "With flood losses it's usually all or none; insurance companies run the risk of being wiped out financially."

Insurers noted that many Holland area corporations are not insured against flood damage either. Corporate insurance deductibles can run as high as $25,000 to $50,000.

Butch Lievense with the Lievense Agency, said after the weekend rain, many homeowners are upset to learn flooding is not covered by their insurance. But, he said, changing agencies will not do any good because flood insurance is generally handled through the National Flood Insurance Program.

Some residents of Holland city, and Holland, Park and Laketown townships can buy the flood insurance, but not every person can. He explained that municipalities must be qualified to have flood insurance sold there by approving certain zoning regulations. It's a long process, he said, and not every municipality goes through it.

Once a municipality is qualified, anyone can apply for flood insurance. In general, Lievense said they would be covered if flooding occurred because of: an unusal and rapid accumulation of runoff or surface waters, an overflow of inland or tidal waters or backed up sewers due to flooding. Damages from mudslides caused by flooding would also be covered, he said.

He noted that people cannot simply run out and buy flood insurance if heavy rain is predicted for the evening, though, because there is at least a five-day waiting period. Additionally, while anyone in Holland can buy the insurance, they may not be able to collect on it if damage was caused by normal cyclical flooding or erosion.

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Streets still closed

By Dave Adamski
Sentinel staff writer

A number of streets in the Holland area will be closed indefinitely because of storm damage, officials said today.

Lincoln Avenue from 16th Street to 24th Street is closed, as is 24th Street from Lincoln Avenue to Apple Avenue. Twenty-fourth Street also is closed from Waverly Road to Country Club Road.

Street supervisor Richard Kappenga said these streets would be closed to traffic indefinitely while repairs are made. Other closed and partially closed streets are located in portions of the city, but should be passable.

Police also said 32nd Street is closed west of Old Orchard Road, and because of the collapse of the intersection of Sixth Street and Chicago Drive,Sixth Street also will be closed.

In Allegan County, road commissioner Fred Niles said eight roads are closed completely, while 55 locations were damaged severely enough to warrant partial barricades or warnings.

Closed are 134th Avenue just east of 28th Street in Monterrey Township; 121st Avenue just east of 36th Street; 41st Street north of M-89; 134th Avenue east of 44th Street; 46th Street south of 143rd Avenue; and 146th Avenue east of 48th Street.

Niles estimated this morning that the damaged roads would cost $500,000 to repair.

In the city,Administration general manager Tim Morawski said the city's sewer system suffered considerable damage in the rainstorm, and while work is underway to repair it, the total damage meted out by nature may not become evident for days.

"We're very concerned that when the water finally does subside (in the sewer system) there is a real likelihood that some of the weaker joints will collapse," Morawski said.

A dollar amount of the damage is not yet available, but Morawski said it would be "a rather large sum."

"And probably the worst of it is coming up," he noted. "If one of those sewer mains collapses it will be very expensive to repair."

In addition to the washouts and flooding that many southside Holland residentsexperienced, sewers began to back up into homes all over the city Sunday, depositing raw sewage into many homes already devastated with flooded basements.

Part of the problem, Morawski said, was that power to the sewage lift station on East Eighth Street across from Russ' Restaurant was knocked out, rendering the pumps inoperable and leaving excess rain water with no place to go except back where it came from — homes.

But even if power to the station had not gone out, Morawski noted, there would have been sewer backups anyway due to excess infiltration of rain water into the sanitary system.

"The sewer system was never designed to handle that much water," Morawski said.

Morawski said the city was hit quite hard with electrical outages, as many transformer fuses were blown by lightning bolt strikes. Although not too many lines were downed in the storm, there were widespread pockets of 4-5, customers without power for several hours in the city. Perhaps 20 percent of the Holland's population was without power for an extended period of time.

Work began at approximately 2:30 a.m. Saturday and continued straight through until midnight Sunday. Eight transformers had to be replaced, Morawski said. All power to private residential customers was restored by Sunday morning, but several businesses remained shut off due to the danger of electrical shock.

In outlying areas, most power was restored by Sunday afternoon, but Consumers Power officials said as many as 21,000 customers in the west and southwest regions were without electricity for several hours on Saturday. Those regions include both Allegan and Ottawa County.

Most of the outages were caused by lightning strikes, which knocked out line and transformer fuses. South of Holland, hardest hit was the Allegan area, where the last customers were returned to service by 7 p.m. Sunday night, while the Wyoming area in Kent County registered most outages to the north and east.

Roger Webb, emergency services director for Allegan County, said $225,000 is his rough estimate to the county in damage to roads.

"And that is just for the county alone," Webb said. "When you add the estimates for villages and cities, the estimates could go far higher."

Much of the damage was confined to the central and north west central areas of the county. At the Allegan Dam 11.3 inches of rainfall was recorded. Allegan was doused with 4.79 inches, and Hamilton got 4.32 inches of the wet stuff, according to Webb.

The Army Corps of Engineers was scheduled to come in and assist in making a more precise estimate of the damages in Allegan County.

Chairman of the Allegan County board of commissioners James Rolfe declared a state of emergency in the county, and preparations are underway to make application for disaster relief.

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Woman trapped in car rescued by motorist

By Katherine Sanderson
Sentinel staff writer

She never gave her name but she will never be forgotten by Jim Bailey.

Bailey is in charge of the power plant at Hope College and was on his way to work Saturday morning around 5:30 a.m. to check out damage to the college caused by the flood.

Bailey, who lives on East 20th Street, arrived at the drainage creek near Hazel Avenue and 16th Street and heard a car horn.

"I thought it might be an (electrical) short (from one of the stalled cars)," he said.

Instead, it was a signal from a woman who had been on her way to work at Heniz. Her car had stalled and was filling up with water.

She was honking the horn in an attempt to get Bailey to call the police.

"She was sitting on the top of the car seat with her keys in one hand and her purse in the other, ready to jump," said Bailey.

He debated whether to go after her, then grabbed a garden hose from a nearby lawn and tied it to a tree.

"It was the closest thing I could get," he said."I didn't know if the bridge was going to go or not."

Frank De Weese, 260 E. 16th St., said Bailey initially tried to get her to grab one end of the hose while he held the other but she wouldn't budge.

"I think she was more frightened than anything else," said De Weese."She could have stepped out but it would have been a little cold."

Bailey then waded out to the car and dragged her to safety.

Bailey, who stands about 5 feet 3 inches tall, said the water was over waist deep as he waded to the car.

The woman then used the De Weese telephone to call her husband. They came back for the car around 10 a.m. and by that time had no trouble getting it started.

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Sentinel photo by David Adamski

Cleanup begins — Troy Webbert, 12, and Todd Van Dyke, 14, pitch in to shovel out what is left of the basement of a home at 401 Lincoln Avenue home Sunday afternoon. A basement wall of the structure collapsed at the height of the rainstorm Saturday morning and mud cascaded inside. The occupant of the home Rose Johnson, 53, was upstairs sleeping when the wall collapsed. Water filled the entire basement up to the top step, and soaked the carpeting and furniture through the floorboards. In addition, a car parked in the garage behind the home floated up and partially went through the back of the structure.

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JULY 17, 1982 STORM

A river ran through us

Heaviest rainstorm in years brings dramatic rescue, flooded yards, washed-out roads

By JOHN TUNISON and MARIE McCAIN
Staff writers

Zeeland Township Firefighter Dave Walcott had practiced water rescues many times.

But it wasn't until Monday's wet weather that he actually put his training to use and saved the life of a motorist whose car went into a flooded creek that washed out the Adams Street overpass near 80th Avenue.

It was one of the many emergencies and hazards that police and firefighters handled as 3.5 inches of rain flooded streets and rivers, blocked roads and threatened a dam in one of the heaviest storms in the area in recent memory. The National Weather Service predicted a 40 percent chance of rain today, but said Wednesday should be dry.

The dramatic rescue came shortly after 6:30 p.m., when a minivan driven by an unidentified man headed veered off Adams and into a swollen creek on the south side of the overpass. Submerged in more than six feet of rushing water, the minivan floated to the surface on the north side of the overpass, where the man climbed out and clung to a tree for safety.

"We could see him and he was petrified," Walcott said. "We put life jackets on and secured ourselves with rope and I went out into the water to get him." The other firefighters stayed on dry ground and anchored Walcott.

A firefighter for 18 years, Walcott said he was surprised by the strength and quickness of the current and found that he was more than a little afraid.

After about 15 minutes of maneuvering, Walcott said he was close enough to catch the man as he let go of the tree.

"You can't imagine how swift the water is moving. The amount of tension placed on the rope was so much that all the excess was taken up. I'm holding on with one hand while I'm trying to hold onto

Please see STORM, A5

CONTINUED STORIES

STORM: *Downpour leaves area roads, yards underwater*

Continued from A1

the tree with the other," he added.

The motorist suffered minor injuries and was treated at the scene.

Driving was an adventure throughout the area Monday, as the relentless pelting overwhelmed drainage systems and closed roads.

Police closed U.S. 31 between 32nd Street and Lincoln Avenue about 2 p.m. after a quarter-mile portion of the highway flooded where it intersects with 40th Street. In the evening, authorities also shut down U.S. 31 near Washington Avenue because of flooding.

U.S. 31 was opened between 32nd and Lincoln Monday evening, but the highway remained closed at Washington until late this morning.

At least four vehicles stalled in Monday's flood on U.S. 31 at Lincoln after drivers apparently tried to push through the water. Within minutes, the water was higher than knee-deep and beginning to lap against the taillights of vehicles.

Tow trucks worked in both lanes, trying to free the cars as the rain fell steadily.

Ron Reister of Alby's Towing originally thought he might be able to pull the vehicles free with a standard tow truck, but decided against it after wading into the waters. He soon radioed for a larger truck with more clearance.

"If the engines are saveable, they'll be lucky," he said, looking toward the mired vehicles.

Holland Police Officer Earl Scholl said drivers often don't realize the seriousness and potential danger of driving through a flooded area.

"They think it's a carnival ride and then they stall," he said, while stationed at one end of the flooded section.

At the high point of the flooding between 8 and 9 p.m. Monday, Ottawa County officials were most concerned about the Timmer Dam on Quincy Street between 48th and 56th Avenues, according to Bill Smith, director of the county Emergency Services Management unit.

Property owners downstream of the dam were placed on alert.

Smith said about 15 inches of water was flowing over the emergency spill level of the dam, but ESM workers were able to stop the overflow and the waters were receding this morning.

All across Holland, the rushing water played havoc, causing partial washouts at the East 32nd Street bridge over the Black River and on East 40th Street just west of Waverly Road. The rain also flooded many streets in the southeast core city.

Water was creeping over the curb on 19th Street and toward Paul Ryan's house near Columbia Avenue Monday afternoon. Although the area is prone to flooding because of old storm sewers, Ryan said Monday's flooding was the worst he'd seen in 14 years.

Ryan said he's learned to live with the flooding over the years.

"There's not a whole lot we can do," he said.

In Zeeland, the Black River overflowed its banks, flooding streets and yards near 104th Avenue and Alice Street.

Water remained several inches deep in Deb Sharda's Alice Street yard this morning.

"You should see our yard. There's debris and logs everywhere," she said.

Sharda said the flooding came just after she finished a lot of hard work to make her lawn beautiful. She said that all of her newly planted perennials probably washed down the river.

"We're going to have a lot of work ahead of us," she said.

Some scattered power outages were reported overnight due to the floods, but by this morning power was restored through out the area.

Ira Krupp, an Ottawa County Cooperative Extension Service agent, said the rain was a setback for farmers just beginning to plant after a cold and wet spring. He said the rain could delay planting another week or more.

MAY 21, 1996 A-1

Sentinel/Cory Olsen

WATER, WATER EVERYWHERE: Motorists traveling on 16th Street between College and Columbia avenues splash through standing water during the height of the rainstorms Monday afternoon. These drivers were lucky — many roads, including U.S. 31 were flooded out by the torrential rain.

MAY 20, 1996 STORM

JUNE 20, 1997 STORM

Any state disaster aid won't come in cash

❑ Emergency management assistance would come in the way of equipmenT to repair storm damage

By ERIC J. GREENE
Staff writer

If Gov. John Engler declares Allegan and Ottawa counties disaster areas and authorizes state aid for flood relief, help could be on the way by next week. But it won't come in the form of money.

More barricades and sandbags, extra trucks and traffic officers might be sent by the Emergency Management Division of the Michigan State Police, but the state provides no money for disaster cleanup efforts.

State legislators have long considered Michigan a "fairly safe state to live in" and don't save money for disaster funds, according to Michael Prince, public affairs officer for the EMD.

Michigan governors have issued 30 disaster declarations in the last two decades, but since Michigan doesn't have the hurricanes, earthquakes and forest fires that occur regularly in other regions of the nation, it has no standing disaster-relief fund.

Allegan County officials had planned to send a disaster-relief application to state officials Wednesday, but county Board of Commissioners Chairman Jon Campbell said damage assessments still haven't been completed.

Campbell said $600,000 is needed just to make storm-damaged roads passable. The damage to county drains is even greater, he added.

"We're conservatively estimating about $1 million in damage to county drains," he said.

County emergency officials have received 40 to 70 calls per day from homeowners reporting damage, Campbell said. He said at least two homes in the Hopkins-Salem area remain underwater and cannot be reached for damage assessment.

"We're conservatively estimating about $1 million in damage to county drains."

Jon Campbell, chairman
Allegan County Board of Commissioners

The Allegan County Road Commission operates on an annual budget of $11,768,000, and county officials claim those funds were exhausted by emergency flood needs.

The Allegan chapter of the American Red Cross set up a special service center for flood victims and has helped more than 100 families since Monday.

Financial contributions can be sent to the Red Cross chapter house at 425 Hubbard St., Allegan, 49010. Anyone with questions can call 673-8640.

On Tuesday, Ottawa County officials estimated the storm damage at $200,000 for county roads and at least $25,000 for county drains. County assessment teams were still gathering damage statistics Wednesday, and a report to the state is expected by this afternoon.

Bill Smith, Ottawa County emergency management coordinator, said he doesn't know if the damage countywide is beyond the county's means.

"We don't know if we will make a formal request or not. When something like this happens, you really don't know what you have until you go through that assessment process," Smith said. If the state does issue a disaster declaration, the only financial help it would provide would come in the form of low-interest loans. Disaster-assistance grants would only come from the federal government.

After counties declare themselves as disaster areas, they have 72 hours to submit a formal damage report to the EMD if they want state assistance. Allegan County submitted its report Tuesday and Ottawa County has until this afternoon.

JUNE 26, 1997 A-3

Allegan, Ottawa await aid requests

By JENNIFER JACOBS
Staff writer

ALLEGAN — Allegan County officials are waiting for Gov. John Engler to declare the county as a disaster area.

If declared, the request could bring aid in the form of personnel, supplies, equipment and materials to county officials working to repair damages to roads and homes after last weekend's thunderstorm flooded areas with 6 to 10 inches of water.

The formal request was signed by Jon Campbell, chairman of the county Board of Commissioners, at 1:01 p.m. Thursday and forwarded to Lansing at 1:10 p.m. The results could take up to a week.

"We are awaiting a decision from the governor, but we don't know what to expect," said Don Martin, director of emergency management in Allegan County.

Also waiting is Ottawa County, where a local state of disaster was declared Monday and officials submitted an initial damage report Thursday afternoon.

Ottawa County Emergency Management Coordinator Bill Smith said assessment teams are still reporting and it is unclear whether the damage is severe enough to qualify for state aid.

"Allegan County is much more severe than what Ottawa County has experienced," Smith said. "If they deny a request for Allegan County, I would say there's no chance in the world that they would do it in Ottawa County."

Damage to roads in Ottawa County is estimated at $200,000. Most residential damages were backed-up sewage lines and flooded basements.

The Allegan County board Thursday approved $50,000 from the county's general fund to help the Allegan County Road Commission offset the costs of already incurred overtime expenses.

At least Allegan County 43 roads were damaged in the deluge. Eighteen of those roads are still shut down. Several portions of roads that are severely damaged are 30th Street south of 140th Avenue, 26th Street between 128th and 140th avenues, and 146th Avenue east of 30th Street.

Allegan County Road Commission Manager Bill Nelson said road repairs will cost more than $500,000.

The county is responsible for 731 drains totaling 715 miles. The preliminary report to the governor states the county will spend $775,000 for removal of sediment and debris, repair of damages and erosion control measures.

Almost 200 homes have reported damage, with two cottages falling into a ravine on Lake Michigan in Glenn Shores. The most heavily hit areas were Salem and Hopkins, where five residences were destroyed, 15 suffered major damage, and 40 minor damage. The state aid would not include help for private home owners.

Also, Campbell has extended the state of emergency period to July 10. It otherwise would have expired Saturday, seven days after the original declaration.

Staff writer Eric J. Greene contributed to this report.

JUNE 27, 1997 A-3

JUNE 20, 1997 STORM

Allegan damage adds up

❑ Farmers were among hardest hit in Friday's deluge

By ERIC J. GREENE
Staff writer

Looking out on his Hopkins farm Monday, Sonny Beard might have had some idea of what Job felt like.

Beard lost two-thirds of his asparagus crop to a spring cold wave. Then the heavy thunderstorms that walloped Ottawa and Allegan counties Friday left virtually all his strawberries and blueberries underwater. It was a combination he found hard to take.

"I'm feeling something's after me. ... You can't hardly take it. It gets on your mind — you can't take it," he said. "You see it on TV and in the paper, but you don't think it can happen to you."

Beard was hardly alone in making damage assessments Monday, as officials continued to total the destruction from the storm that led Allegan County officials to apply for state disaster assistance.

Don Martin, Allegan County's emergency management coordinator, reported Monday that 34 roads will require structural repair and many more will need minor repair such as shoulder work.

Many roads are still impassible.

In addition, five homes in the county were reported destroyed, 17 with suffering major damage and 135 minor damage. One business was reported destroyed, three with major damage and 20 with minor damage.

Martin said these damages are the basis for the application the county will submit today to the Michigan Emergency Management Division, which will determine whether it qualifies for state disaster assistance.

That assistance would likely come in the form of personnel, equipment and supplies.

Please see ALLEGAN, A5

ALLEGAN: *Damage adds up*

Continued from A1

"It has not been our experience that we've had two events like this that brought major flooding," said Bev Green, deputy drain commissioner, comparing the weekend's flooding with a major storm that hit the area in June 1996.

She said planning for weather events like the storms of the last two Junes is almost impossible because of the vast infrastructure improvements necessary to hold all of the water that falls in a 10-inch rainstorm.

"Most people couldn't afford the cost of a project (residential or commercial) that was oversized enough to allow for that kind of drainage," she said.

While water receded in much of the county, it intensified in the Saugatuck area, where the Kalamazoo River rose an estimated five feet before cresting late Monday morning as water released from two dams in the Allegan area moved toward Lake Michigan.

Many docks and seawalls in Saugatuck were covered with water Monday, and a number of waterfront homes and businesses were flooded.

"It continues to get a little better in some spots and a little worse in others," said Martin.

An inspection of Allegan County farmland by Paul Wylie, the county's Michigan State University agricultural extension agent, varied widely, with damage extensive in low-lying areas near rivers and streams but other areas largely unscathed.

Immature corn and soybeans flooded in the storm may be lost completely, Wylie said.

"If they're submerged for 48 hours, it pretty much kills them," he said. "The corn and soybeans were off to a bad start to begin with, so we'll have a below average harvest."

In his tour of the county this weekend, Wylie saw substantial soil erosion too.

"Some of the fields are going to need extensive repairs, even using bulldozers. You can't run today's expensive farm equipment on land that's been torn up like this," he said.

Beard, whose land lies near the swollen Rabbit River, said Friday's storm overflowed his 6-inch rain gauge.

"I've seen heavy rains before, but I've lived here 30 years and never saw water in my basement before. I had a foot and a half," Beard said.

He said most of his 20 acres of blueberries are under water and figures he lost 75 percent of his 6 1/2 acres of strawberries. He said the rain and flooding could not have come at a worse time because most of the strawberries were ripe and ready to harvest

The National Weather Service reported that 10.2 inches of rain fell Friday and Saturday at Holland State Park, though the official reading for the city — taken at the Kollen Park fire station — was just 4.1 inches. However, that level is still the third highest recorded in a 24-hour period in Holland.

In Holland, city street crews spent Monday repairing roads taken out by flooding. Gravel washed away on a portion of Country Club Road and a piece of 24th Street behind Van Raalte Farm, spanning one lane, collapsed.

"We were fortunate that the damage to our streets was minimal," Holland Community Services Director Dale Wyngarden said. "But we don't need many more of these."

Staff Writer Jim Timmerman contributed to this article.

JUNE 24, 1997 A-1, A-5

Helicopter picks up stranded men

❑ Best friends were on their way to birthday celebration when they ran into high water

By ERIC J. GREENE and MICHAEL J. UREEL
Staff writer

Rudy Diaz was elated on the night of his birthday.

Not only did he have some of his best friends at his 21st birthday party Friday, but also the Holland Police Department, Ottawa County Sheriff's Department, Park and Zeeland fire departments, Southwest Ottawa Dive Team and the United States Coast Guard.

Talk about some party.

Diaz and three of his friends were plucked by a Coast Guard helicopter from their overturned Suzuki Sidekick as it lay in a flooded-over section of the Black River at 80th Avenue and Adams Street early Saturday morning.

"I'll never forget this birthday," said Diaz of Fennville. The four were en route to Holland to celebrate Diaz's 21st birthday.

They were driving westbound on Adams at about 11 p.m. when they hit the water-covered bridge.

"We didn't even notice it until it was in our windshield and it pushed it to the side and down the river," said Paul Martinez, 22, of Fennville, who was driving the vehicle. The other two passengers were Russ Garcia, 21, of Holland, and John Bronson, 22, of Fennville.

After the vehicle was turned over, the four climbed onto it side and began whistling for the attention of homeowners nearby.

"We got out and sat on it and we saw someone at the house and we started whistling and they heard us," said Diaz.

Lori Sanssen, 20, of Zeeland Township, heard Diaz and his friends from her home.

"We saw some headlights and the next thing I knew there were people yelling for help," said Sanssen. "We called 911."

Rescue crews first dispatched to the scene called in the Coast Guard from the Muskegon station. Pilots made the flight in 25 minutes and lifted each of the stranded men from the vehicle to stable ground at about 12:30 a.m.

After warming up with blankets in a rescue van, the four went home, planning to celebrate the birthday Saturday night.

"We figured we better celebrate that and our little brush with death," Diaz said.

The successful rescue was perfect training for the Southwest Ottawa Dive Team, which had practiced rescue maneuvers with the same Coast Guard pilots just a day before at Kollen Park in Holland.

"We had talked about how the helicopters operate, how to tie people on and how to use the basket," said team co-captain Kirk Briggs. "We proved that we work quite well."

Briggs said the pilots showed their talents by flying in Friday night's severe thunderstorm. The dive team had boats and wet suits ready as a back-up plan if the helicopter was unsuccessful.

JUNE 22, 1997 A-1

JUNE 20, 1997 STORM

Calm after the storm

Storm facts

- More than 10 inches of rain fell Friday and Saturday.
- A local state of disaster was declared for Allegan County on Saturday.
- 7,000 Allegan County residents were still without power Saturday. The power may not be restored to some until Monday.
- Allegan County flooding caused 34 road closings, two collapsed roofs and a cottage in Glenn Shores to slide into Lake Michigan.
- 2,400 Ottawa County residents were without power Saturday.
- In Ottawa County, six bridges were damaged, parts of 40 roads were impassable and 50 homes experienced flooding.

Sentinel/Brian Forde

RAGING WATER, GOOD FISHING: Ken and Sherry Lovely of Hamilton try to land the big one at Allegan Dam Saturday. Due to high water levels, the dam's gates were raised creating a rush of water which made for excellent fishing.

Allegan declared disaster area as cleanup begins

By ERIC J. GREENE
Staff writer

Today's forecast for sunshine may provide much-needed relief for parts of Allegan and Ottawa counties that were inundated with more than 10 inches of rain in the past two days.

The bulk of the rain was in Holland Friday night, but the most significant flood damage was in Allegan County, where a local state of disaster was declared early Saturday morning.

Flooding in Allegan County is concentrated in the northern townships of Overisel, Hopkins and Wayland, but even more serious is the threat of a dam break in the city of Allegan.

As water flowed over the top of the dam Saturday, city officials opened its two main flood gates to drain the water downstream toward Lake Allegan. Another dam, owned by Consumers Energy, was also opened on the west end of Lake Allegan.

"There's a possibility of more rain coming and we know that the surge of water coming from tributaries and streams is still coming, and that's going to push another surge of water," said

Please see RAIN, A2

Inside

Sentinel/Brian Forde

RISING: The Black River passes inches below bridge on Chicago Drive Saturday. A work crew scrambled to shore up the repairs and move back equipment that could be swept away by the rising waters.

JUNE 22, 1997 A-1

JUNE 20, 1997 STORM

Allegan assesses damage from heavy rains

❑ County officials plan to seek disaster aid

By JENNIFER JACOBS
Staff writer

ALLEGAN — Officials and Red Cross volunteers spent a second day Sunday visiting homes and businesses in Allegan County to assess damages from a deluge of more than 10 inches of rain over the weekend.

In one shoreline community, the damage was plenty evident, as two cottages along on Orchard Lake Drive in Glen Shores fell into a hole created by groundwater runoff on the shore of Lake Michigan.

Sue Fattore, who owns a cottage two doors down, was amazed by the destruction.

"I can't believe the water did this," Fattore said as she inspected the scene Sunday. "What kind of catastrophe are we in for next? I've never seen anything like it."

Teams have through early Tuesday morning, to compile and submit damage assessments to the Michigan Emergency Management Division in Lansing to request financial aid from the state.

The county was declared a disaster area at 2:11 a.m. Saturday morning when officials determined that local and county resources were unable to handle the flood situation. Officials plan to present the aid request tonight.

"The aid could open up doors for a wide range of damages," Allegan County Undersheriff Larry Ladenburger said Sunday. "We need to show the severity of damage, the number of homes affected and meet those criteria for them to say we've reached a major disaster."

If the state EMD agrees that county resources are exhausted, it will recommend to Gov. John Engler to declare Allegan County a disaster and authorize aid.

On Sunday, eight teams reported on flooded basements and other damage caused throughout the county, Ladenburger said.

Residents in Glen Shores were also out inspecting the remains of the two cottages that collapsed.

Neighbors said the first cottage collapsed Friday night and the second about 11:30 a.m. Saturday after half of the structure teetered for most of the night. Friends were able to get the owner out and salvage some furniture.

"We heard the storm but we didn't hear anything else," said Jim Brown, the new neighbor of the ravine that opened up 150 feet back to the road. "We drove past in the morning and part of the house was over thin air."

Brown, who is not worried about losing his cottage, said there was a natural stream under the cottages that was part of the drainage system that backed up. The ensuing sand flowed about 20 feet out into Lake Michigan from the bottom of the bluff, creating a new beach out of quicksand.

More than 34 roads were closed in Allegan County and both gates of the dam in the city of Allegan were raised to alleviate the threat of a break after water flowed over the top.

Please see DAMAGE, A5

Sentinel/Zachary Johnson

GOING DOWN: The remains of a Lake Michigan cottage sits on the bluff just off Orchard Lake Drive in Glen Shores Sunday. It was one of two homes that collapsed when rain and draining groundwater caused the bluff to collapse. Allegan County officials are still assessing damage from the weekend deluge as they prepare to seek state disaster aid.

JUNE 23, 1997
A-1

DAMAGE: *Allegan may seek state aid*

Continued from A1

"We're in no danger losing it right now," Ladenburger said. "There's a lot of water swirling and it's holding quite well."

Another dam was also opened on the west end of Lake Allegan.

Road commission crews were filling in washouts and lost tubes so roads wouldn't be lost for good in the hardest hit townships of Overisel, Hopkins, and Wayland.

"There's going to be a lot of roads closed for most of next week," Ladenburger said.

In Ottawa County, six bridges were damaged, parts of 40 roads were impassable and 50 homes experienced flooding.

County officials are also preparing a report to submit to Lansing to see if any aid is necessary, Ottawa County Emergency Services Director Bill Smith said.

"There's going to be a lot of roads closed for most of next week,"

Allegan County Undersheriff Larry Ladenburger

"We should know something in a few days," Smith said.

Bill Sikkel, of Holland and vice-chairmen of the Allegan County Board, couldn't estimate on the dollar loss Sunday, but said today could bring more surprises.

"I'm sure there are some businesses that are going to be surprised Monday morning by water damage, but we're trying to build a number bank on the number of properties impacted," Sikkel said. "I presume they're going to get a handle on it."

Officials are concerned with the effect of standing water on crops already behind for the season.

Standing water of more than two days is apt to kill crops of small size, said Paul Wylie, agricultural agent with the MSU Extension office. Wylie, along with the Farm Services Director of Allegan, plans to tour the county today.

"The erosion had to have been terrific," Wylie said. "It might have washed some of the crops right out of the ground."

Corn and soybeans can sit for a while in water, but potatoes, onions and cucumbers are at risk, Ladenburger said.